

Information Literacy in the Laptop Classroom

MARK WARSCHAUER

University of California, Irvine

Background/Context: *Technological and economic changes have put a high premium on developing students' information literacy and research skills. Previous attempts to deploy educational technology toward these ends have proved disappointing because K–12 teachers have difficulty integrating shared computers into instruction. In response, numerous schools and districts have piloted one-to-one programs, in which each student has access to a laptop computer connected wirelessly to the Internet throughout the school day.*

Purpose/Objective: *This paper analyzes the information literacy and research practice in a purposely stratified selection of 10 one-to-one laptop K–12 schools in California and Maine.*

Research Design/Data Collection and Analysis: *Sources of data in this multisite case study include observations, interviews, surveys, and teacher- and student-produced materials.*

Findings/Results: *The study found that students in all the laptop schools learned to access information, manage it, and incorporate it into their written and multimedia products. However, the focus on evaluating information, understanding the social issues surrounding it, and analyzing it for the purpose of knowledge production varied widely across schools. Some schools succeeded in promoting scholarly approaches to working with information, whereas other schools mostly limited themselves to teaching procedural functions of computer and Internet use. Examples of these differences are given through a comparison of three diverse schools in Maine.*

Conclusions/Recommendations: *The study concludes that one-to-one wireless laptops offer important affordances for promoting information literacy and research skills but that socioeconomic context, visions, values, and beliefs all play a critical role in shaping how laptop programs are implemented and what benefits are thus achieved.*

Recent decades have witnessed the most rapid advances in the means of communication and knowledge production since the advent of the

printing press (see discussion in Harnad, 1991). These technological changes have in turn made possible a new stage of capitalist development, termed *informationalism* by Castells (1996). In informational or postindustrial capitalism, raw infusions of capital or labor are much less significant to economic advancement than is the ability to accumulate and analyze information and turn it into knowledge.

The jobs that drive the new knowledge economy and provide people with power, prestige, and high pay are almost all in what former secretary of labor Robert Reich (1991), called *symbolic analyst services* and include professions such as research scientists, design engineers, management consultants, strategic planners, marketing strategists, and production designers. Symbolic analysts must be highly analytic in their use of information, persuasive and creative in their communications, and autonomous and flexible in their ability to manage tasks from a number of simultaneous projects. Most symbolic analysts use digital technology on a constant basis to network with others, seek or analyze information, and create multimedia products for diverse audiences. They require a high degree of *information literacy*, defined as the ability to access needed information effectively and efficiently; evaluate information and its sources critically; incorporate selected information into one's knowledge base; use information effectively to accomplish a specific purpose; and understand the economic, legal, and social issues surrounding the use of information (American Library Association, 2000).

These technological, economic, and workforce changes have prompted educational reform efforts so that schools can better help students develop the skills in accessing and using information, conducting research, and producing knowledge that are required in this new century (see, for example, North Central Regional Educational Laboratory & the Metiri Group, 2003; Partnership for 21st Century Skills, 2004). It has long been believed that incorporating greater amounts of technology into schools would help foster such reform (see Culp, Honey, & Mandinach, 2003). In pursuit of improved education, the United States has decreased its average student computer ratio from an estimated 168.0 in 1983 (Anderson & Ronnkqvist, 1999) to 3.8 in 2005 (Market Data Retrieval, 2005).

Yet research suggests that the computerization of schools has not achieved its goals because a range of logistical, administrative, and pedagogical obstacles make it difficult for teachers to effectively deploy shared computers (see, for example, Cuban, 2001; Warschauer, Grant, Del Real, & Rousseau, 2004). The need to schedule computers in advance is one major obstacle toward effective integration of technology into instruction, and students' unequal access to computers at home represents

another challenge (see study by Warschauer et al., 2004). As a result, only a small percentage of teachers make use of technology on a frequent basis, and use is even rarer in academic subjects (Becker, 2000b; Cuban). In addition, unequal patterns of technological access and use in society get reproduced in schools as teachers make use of limited computer resources to benefit the most able or privileged students (see Schofield & Davidson, 2004).

To overcome these problems and better incorporate technology into instruction, increasing numbers of U.S. schools are turning to one-to-one laptop programs (for overviews, see Johnstone, 2003; Rockman, 2003). In these programs, all the students in a class or school receive laptop computers for use throughout the school day and, in most programs, at home. By eliminating obstacles of sharing computers, scheduling computer use, bringing students back and forth to computer laboratories, and unequal computer access, laptop programs seek to achieve a more natural integration of technology into instruction. One-to-one instructional programs invariably involve wireless access to the Internet so that students have online information available to them throughout the day, as would any typical knowledge worker in the United States.

Dozens of research studies have been published on laptop use over the last several years, and many of these studies suggest positive outcomes (Penuel, 2005). Yet most of these studies lack methodological rigor (see critique in Penuel), and most are based in only one or two schools. The larger published studies (e.g., Silvernail & Lane, 2004) have been principally based on surveys, with relatively little direct observation of what takes place in the laptop classroom. Finally, though a number of the studies have touched on how laptops are used for information access, information literacy development, and research (see, for example, Walker, Rockman, & Chessler, 2000), none of the studies to date focused on information use and research as the central question.

METHODOLOGY

This article presents findings from a 2-year laptop and literacy study conducted from 2003 to 2005. A complete report on the findings can be found in Warschauer (2006). In this article, the data are summarized with respect to the following research questions: (1) What patterns of information use and research were noted in the laptop classroom, and how did they compare with what teachers and students said was typical in their prior nonlaptop classes? and (2) How did approaches to information use and research differ according to the social context of laptop schools?

The study is based on an examination of laptop use in a purposely stratified sample of 10 schools in two states (see Table 1). All the schools were either in Maine (3 schools) or California (7 schools). Maine represents a state with high test scores, a history of progressive education, a relatively homogenous population as to ethnicity and language, and a public statewide laptop program. California represents a state with many failing schools, an educational climate dominated by conservative approaches to raise test scores rather than progressive education, a highly diverse population as to ethnicity and language, and a hodgepodge of pilot laptop programs launched in individual schools and districts. The sample of 10 schools in the study includes two elementary schools, four middle or junior high schools, three high schools, and one combined elementary-junior high. Students in these schools use laptops in grades ranging from Grade 2 to Grade 12. The schools are located in urban, suburban, and rural settings and are located in wealthy, middle-class, and poor neighborhoods. The ethnic composition of the schools varies widely, with

Table 1. School Sites

School	Grades of Laptop Program	Location	Principal Ethnic Groups	SES	Program	Funding	Platform
Henry Elementary	3-6	Suburban, California	White, Asian	High	Gifted	Parental Lease	Macintosh
Flower School	3-7	Suburban, California	Asian, White	Medium	General	Parental Lease	Macintosh
River Elementary	4	Urban, California	Latino	Low	Language Arts/ESL	Private Grant	Windows
Nancy Jr. High	7	Urban, California	Latino, White	Low	General	Federal	Macintosh
Howard Middle	7-8	Suburban, Maine	White	High	General	State	Macintosh
Castle Middle	7-8	Urban, Maine,	White, Black	Low	General	State	Macintosh
Freedom Middle	8	Urban, California	Black, Latino	Low	Alternative /At Risk	Private Grant	Macintosh
Carlton High	9-12	Urban, California	Asian, White	Medium	Academic Core	Parental Purchase	Windows & Macintosh
Melville High	9-12	Suburban, California	White, Latino	High	Academic Core	Parental Purchase	Windows
Plum High	9-12	Rural, Maine	White	Low	General	State and Private	Macintosh

Note: All names are pseudonyms. In a previous article (Warschauer et al., 2004), Castle Middle was referred to as Urbania Middle.

Whites, Latinos, Asians and Asian Americans, and African Americans each forming the largest ethnic group in at least one school. Most of the schools in the study have integrated laptops into their general school programs, but in certain schools, the laptops are principally or even exclusively used in special programs, such as those for at-risk or gifted students. Funding for the laptop programs is provided from a variety of federal, state, and private sources, including, in some cases, parental purchase or lease, and the platforms deployed include Windows and Macintosh, and, in one school, both.

Research at the schools was directed by the author and was carried out by a team of faculty, graduate students, and undergraduates (see Acknowledgments). Data collection at the schools involved a combination of observations, interviews, surveys, and document review. In 6 of the 10 schools, a team of researchers visited the school part of the day approximately 1–2 times per week for most of a school year to conduct the research. In 4 of the 10 schools, the research was more intensive, with a team of researchers visiting the school all day for 4–5 days over a 2-week period. At all the schools, the administration allowed us to observe and interview whomever we wished, but participation by any individual teacher, parent, or student was voluntary. About 5–7 individual case study students were chosen at each school to represent the diversity of students at the school (by grade level, language background, gender, ethnicity, and whether they were high or low achievers).

A total of 650 hours of classroom observations were conducted at the 10 schools, with detailed field notes taken during all observations. Interviews were conducted with a total of 61 teachers; 32 other school staff (administrators, librarians, counselors, or technology coordinators); 67 students; and 31 parents. Interviews ranged from 20 to 60 minutes, and a number of the people were interviewed multiple times. All interviews were tape recorded and transcribed.

Teachers and students in 3 of the 10 schools completed a voluntary anonymous online survey with a response rate of 100% of the teachers (35 out of 35) and 86% of the students (877 out of 1,012). We also collected documents and records from individual schools, including school, district, and state policy documents; print and digital teaching materials; print and digital assignments completed by case study students; and, in some cases, school or student test score or attendance records.

Data were analyzed through standard qualitative methods, first to identify key patterns within each research site, and then to make comparisons and find commonalities or differences across research sites. To facilitate this analysis, all the interviews and field notes were coded with the HyperRESEARCH (2005) software program, using a bottom-up coding

scheme that considered whatever items of interest emerged from the data related to the overall theme of literacy and learning with laptops. A total of 381 separate codes were generated (e.g., “evaluating online material,” “data-based learning”), and 3,397 instances of these codes were marked.

No qualitative data were gathered from nonlaptop classrooms or schools. However, by interviewing and surveying students and teachers about the perceived differences between the laptop and nonlaptop classroom, and triangulating these opinions with observations and other data sources, we were able to make tentative comparisons.

FINDINGS

Our research suggests that students in the laptop schools universally learned to access information, manage it, and incorporate it into their written and multimedia products. On the other hand, the focus on evaluating information, understanding the social issues surrounding it, and analyzing it for the purpose of knowledge production varied greatly across schools.

We will proceed with two broad comparisons. First, we will take the laptop schools as a group and discuss how information literacy practices and research activities in the laptop schools differ from those in typical classrooms. We will then offer some comparisons among laptop schools, drawing on examples from the three Maine schools to demonstrate how different contexts and approaches combine to yield differing strategies on promoting information literacy and research skills.

INFORMATION AND RESEARCH PATTERNS IN LAPTOP SCHOOLS

Students in laptop schools had access to a much greater variety of information than do typical students. According to both our surveys and those of others (e.g., Bebell, 2005; Silvernail & Lane, 2004), gathering information online is one of the most frequent educational activities carried out with laptops. In addition, individual laptops can be a tool for gathering data (for example, when attached to scientific probes) and for analyzing data (through spreadsheets, graphing software, and so on).

This ongoing access to tools for gathering and analyzing information brought about five important changes in instruction: It facilitated (1) more just-in-time learning; (2) more autonomous, individualized learning; (3) a greater ease of conducting research; (4) more empirical investigation; and (5) more opportunities for in-depth learning. Each of these five changes will be briefly discussed.

JUST-IN-TIME LEARNING

Cognitive scientists have long known that people learn best when information or instruction is provided at the point of need (see discussion in Gee, 2003). Yet this important learning principle is difficult to implement in a typical classroom, when a teacher cannot necessarily anticipate every learning opportunity that may emerge, or, even if anticipated, may not have the opportunity to locate and reproduce materials on the topic.

Just-in-time learning occurred with great frequency in the classrooms that we observed. Language arts students went online to find information or images to clarify confusing terms or concepts that they came across in medieval literature. Science students consulted revolving 3-D models of DNA to answer questions that came up in class. And social studies students frequently sought out information regarding current events related to classroom discussion.

Teachers often refer to this process as taking advantage of *teachable moments*. The phrase was used a number of times in our interviews. As a teacher at Flower School in California explained, discussing the value of just-in-time learning for her highly curious third graders:

The kids have so many questions and the computer just opens a brand new world. It used to be if a teachable moment arose, then “well, tomorrow we’ll find out about that.” Now it’s “OK, would you open your computer and let’s go find out,” and we can take them right now and they get excited about it. Right now, we are doing a study on symbols of our nation. We go search the Statue of Liberty. We can take a virtual tour of the White House, or Congress, or the Supreme Court. They can go there and be a part of it. And they could not get out before. They had to rely on the books that were just meant for every student in every state across the nation.

At the opposite end of the K–12 spectrum, several high school teachers discussed the value of students’ accessing information on the Internet just when they need it. An English teacher at Melville High in California explained that he never felt so empowered as a teacher until now, when he can introduce his students to diverse poets, even those not included in the student’s textbook, because his students can access a wealth of poetry on the Internet. A social studies teacher at the same school went to some length in explaining how just-in-time learning has transformed his teaching:

When I initially started the [laptop] program, I didn't think it was going to have that much of an effect. I kept thinking, well this will be fun to try, but I still need to use the textbook and I still need to go over all the curriculum and I need to cover these areas. What I found was, literally in my first 2 years, I almost had to rewrite the curriculum. It was just that I had a door totally open up to me in terms of culture, geography, current events, news, all of the things that I have been trying to get my students to learn from a textbook: language, what this sounds like, what that looks like, these five different cultures that live in one square mile, this civil war, that political situation. All these things that I've been trying to use, pretty much without my hands on, became literally at their fingertips. I would say from the first 2 years I was teaching Cultural Geography till now, they're learning something totally different than my students did in the first 2 years. We literally have a globe at our fingertips. That's the difference. I can make the Zulu tribe in South Africa come alive for them versus talk about these people that they've never seen, they don't know, they can't grasp. And where I was using a newspaper article of the previous day's news to deal with current events, we can literally track an event hour by hour online and change the discussion minute by minute. It totally involves them 100% in the news.

The views of these teachers were typical of what we found in the laptop classroom. One of the greatest benefits of one-to-one learning, in teachers' eyes, is the wealth of information that can be brought into the classroom at the time that students can best make use of it.

AUTONOMOUS AND INDIVIDUALIZED LEARNING

Another advantage of information access that we witnessed in the laptop classroom was more autonomous and individualized learning. Because of the vast array of content available online, teachers found it much easier to individualize instruction and devolve decisions about information and content to students.

One very simple example of this occurred in a social studies class in Maine, in which students went online to peruse political cartoons once a week (located at Cagle, 2006). The teacher explained that, prior to the laptop program, she picked out one or two cartoons herself to show to the class. But with one-to-one laptops, students were able to search out cartoons that they found particularly interesting and then take turns

explaining them to the rest of the class.

One example with interesting cultural implications occurred at Castle School in Maine, where we witnessed a student from Somalia working by herself in the library, where she was browsing a Web site on alcohol and drugs. She explained that the rest of her health class was receiving sex education instruction, but because her mother would not permit her to participate, she was doing individualized substitute research on her own.

A high school teacher in California explained to us how laptops helped her provide more autonomy for her students in finding and evaluating information. Her comments were typical of what we heard from many laptop teachers:

I always started out before thinking it has to all come from me. I have to be the center. What I tend to do now, though, is give them a background, give them a core of information, or show them where to find the background information, or show them how to evaluate the information I give them, or use the media to evaluate what's happening. I really think in laptop class it is going to be student centered because you have a laptop and it can take them anywhere. It's more teacher as a facilitator. I'm a tool they can use too, but there are so many other tools, and they need to know how to utilize all of the tools. So the curriculum is like a vehicle to teach them how to utilize the resources and utilize them to create products that are useful for their learning. And ultimately when they are adults out there, no matter what job they happen to be in or whatever they do with their lives, they need to be able to utilize any resources they're exposed to. It's more of a focus on what students can do with these tools to enhance their learning. And they enjoy that. They like to have control and it really does allow them to be in control.

EASE OF RESEARCH

Perhaps the most valuable aspect of information access in the laptop classroom is how it facilitates student research. Teachers and students pointed to several factors about the Internet in facilitating student research. First, the Internet has far more information than most school libraries. Second, the information on the Internet is more current, an important factor given the rapidity of scientific development and social change. As one student told us, "the [print] encyclopedias in our library are from the 1990s, so the newer information is on the Web." Third, it is often much easier and faster to find information on the Internet than in

a library. Fourth, the Internet can be accessed directly from the classroom and, for many students, at home as well. Fifth, it is easier to manage, archive, and copy information from the Internet than information in print (though the last point can sometimes be a disadvantage and an advantage). And finally, one-to-one Internet access makes teachers' jobs much easier because they don't need to spend as much time tracking down print resources and photocopying them for the classroom.

For example, Ms. Sharpe, a health teacher at Nancy Junior High in California, assigned her students a research project on school violence. The students gathered information for the study from Web sites recommended by the teacher, with current data, articles, and cartoons on violent acts in schools. Ms. Sharpe told me that, without the laptop program, such a research project would have been very difficult to arrange. As she explained,

Most of that information [on school violence] is compiled through various agencies and it would have been really hard and really time consuming to do that research in any other way. I don't think there would have been another way other than me researching it and printing it out for them.

Similarly, another teacher at the same school assigned her students a research project that examined tobacco advertisements aimed at youth. The students based their research on materials available through a public health Web site (Campaign for Tobacco-Free Kids, 2006) that would have been extremely time consuming to find without the Internet.

Of course, the very ease of finding information online creates special challenges for learning how to sort through, select, evaluate, and make use of such a wealth of content. A number of the schools developed special information literacy training modules, sometimes with the assistance of the school library, as illustrated later in the discussion of Howard Middle School. Depending on the students' age and literacy level, teachers also provided appropriate forms of scaffolding. For example, in the school violence research project discussed above, which was carried out among seventh-grade students, including many English language learners, the teacher directed students to 12 preselected Web sites on school violence rather than just setting students loose to search the Internet themselves. In other cases, teachers make use of specialized search engines for schools, such as NetTrekker (Thinkronize, 2006), or set up guided information-seeking activities called WebQuests (Dodge, 2005).

Another potential problem with ease of research is plagiarism. Teachers came up with various strategies for discouraging plagiarism.

One science teacher in Maine explained that she likes “taking two events that seem unrelated and having kids try to figure out the commonalities and the differences.” She finds that such a strategy forces students “to do something that you can’t get from anywhere else. It has to come from your head.” In the same vein, other teachers explained that their research assignments require students to give their opinion and support it by citing facts. Because the students spend a lot of preparatory time in class developing and sharing their opinions, the teacher believes that this discourages cutting and pasting from the Internet.

In our own somewhat limited observations—we could not read all the essays of the many thousands of students in the schools we visited—we were not aware of any blatant attempts at plagiarism. We did, however, sometimes witness students lazily cutting and pasting information from the Internet into their products (e.g., posters or slide presentations) without even attempting to pretend that they had a hand in authoring the material. Unfortunately, such behavior was occasionally abetted by teachers who were so impressed that students had created a nice-looking poster or presentation that they didn’t bother to critique the included textual content.

DATA-BASED AND HANDS-ON LEARNING

The use of one-to-one laptops also provided greater opportunity for students to work directly with data themselves. By gathering and analyzing data, they could engage in more direct forms of experimentation and research rather than the secondhand research that is more typical of K–12 schools.

Sometimes the data that they analyzed came from the Internet. For example, at Freedom Middle School in California, a one-to-one laptop program was launched in the alternative education program as a way of trying to better connect to students who were on the verge of dropping out or failing out of school. The teacher there actively sought ways to relate instruction to the students’ personal lives. One particularly interesting research activity involved students going to Web sites that had both test score and demographic data from schools in the district. Students drew on these data to make charts comparing test score outcomes to income levels (as measured by percent of students receiving free or reduced lunch in particular schools). The activity involved students in animated and thoughtful discussion about what factors might lead to the high correlation between these two measures. It drew students into the intellectual issues much more readily than if the teacher had prepared a lecture on the topic of school equity without involving students in actively

looking at data related to their own lives and community.

In other cases, students collect the data themselves—for example, by conducting surveys of classmates or taking measurements of objects or events in the classroom and using spreadsheets or online graphing tools (e.g., National Center for Educational Statistics, 2006) to analyze the data. For more sophisticated forms of data gathering, some of the schools purchased scientific probes. For example, the science teacher at Flower School in California had access to a set of digital probes and microscopes that attached to the laptops for gathering and uploading data related to temperature, voltage, light, force, motion, and chemical composition. In one lesson we observed, seventh-grade students worked in groups to measure each other's heart rates in various states (sitting, standing, jumping) and uploaded the data to computers, where they were plotted into graphs. In the process, they developed and tested hypotheses about the effect of various combinations of activity and rest on heart rate.

Finally, online simulation software provided another form of hands-on, interactive learning for students in the one-to-one programs. Students in classes we observed carried out simulated frog dissections (Froguts, 2006), performed virtual open heart surgery (Columbus Medical Association Foundation, 2006), and witnessed simulated cell mitosis and meiosis (Quill Graphics, 2006).

IN-DEPTH LEARNING

Most of the teachers in our study believed that continual online access contributed to more in-depth learning in the classroom. In our survey, for example, 90% of teachers agreed that “students in laptop classes explore topics in more depth”; 85% of teachers expressed agreement with the statement that “students in laptop classes get more involved in in-depth research.”

A common belief in this regard, and one that we frequently saw evidence for in the classroom, was that Internet-connected laptops offered students many alternative ways for attacking an issue or problem, thus allowing them to explore a topic more deeply than in a typical classroom. We thus witnessed a good deal of project-based work, consistent with what many scholars have said best brings out the potential of technology use in the classroom (see discussion in Becker, 2000b; Sandholtz, Ringstaff, & Dwyer, 1997).

A teacher in the Gifted and Talented Education (GATE) program at Henry Elementary School, Mr. Spratt shared his thoughts on the matter, which were consistent with what we observed in his class:

A great benefit is being able to integrate across the curriculum. In the GATE classes, we work on the issues of depth and complexity—how to notice patterns, trends, details, rules, different perspectives, big ideas. Now, I can integrate better across the curriculum, go deeper. I can also emphasize some of the scholarly attributes we are trying to promote, like showing curiosity, showing academic humility, being prepared with learning tools, considering multiple points of view.

To illustrate this point, Mr. Spratt discussed two interesting math projects that his third/fourth-grade class carried out. In one of the projects, students went online to find the California mathematics standards for second grade, worked in groups to design and create games that could help teach these standards, and videotaped themselves providing instruction to the second-grade class on how to play the games. In the second project, students were given fictitious \$1,000 accounts to buy holiday gifts for their friends and family. The students then went online and did comparison shopping from nine different stores, calculated tax according to appropriate parameters, designed their own checks and made simulated purchases, created and updated charts with information about their purchases, made graphs of their spending patterns, designed and produced a poster board on the project incorporating their diverse materials, and wrote reports about the project. Mr. Spratt explained that he had attempted to carry out this holiday math project in previous years, but that, prior to the laptop program, “I basically had to hand feed them a lot of the information.” Now armed with laptops, they were able to approach holiday shopping from a variety of perspectives and go into the topic in more depth.

VARIATION AMONG SCHOOLS IN INFORMATION LITERACY PRACTICES

The above five changes were general patterns that we noticed across the laptop schools. At the same time, there was also a good deal of variation among schools. Some schools were highly successful in promoting information literacy, research skills, and in-depth learning with laptops. Other schools were only moderately successful. And in a few cases, we observed teaching and learning that could best be described as shallow.

We believe that these differences can be explained by an *amplification* effect (see discussion in Warschauer, 2000). Simply put, those teachers and schools that began with strong instructional programs for critical inquiry and research were able to make use of laptops to magnify the

success of such instruction. Those schools that began with a weaker focus on inquiry and research had less success in even developing the basics of information literacy. The distinction between strong and weak schools in this regard tended to correlate with socioeconomic status (SES). Schools in high-SES neighborhoods in this study, in general, tended to have more experienced teaching and administrative staff, a community of parents with higher educational expectations, and a student population that had been primed since an early age to prepare for college. All these factors tended to contribute to a stronger research focus at the high-SES neighborhood schools than at their low-SES counterparts. At the same time, important exceptions existed, with some of the low-SES neighborhood schools doing an excellent job of promoting information literacy and developing student research skills.

To illustrate the wide variation in approaches to information literacy and research, we briefly look at three laptop schools in Maine: Howard Middle, Plum High, and Castle Middle. We found similar patterns of differences among schools in California as in Maine, but the California programs varied in many other ways as well, with some taking place in a single class or subject area, and some involving grade levels, schools, or districts. We thus focus on the three Maine programs, all of which took place on a schoolwide basis as part of a broader state initiative, because they provide a clearer example of differences among schools in relationship to information literacy and research.

DEVELOPING SCHOLARS AT HOWARD MIDDLE

Most well-populated states feature dichotomous divides between run-down inner cities with large numbers of minorities (Blacks and Latinos), and well-off suburban areas that are mostly populated by Whites. However, Maine—with a 97% White population, relatively few non-native speakers of English, and no cities of more than 65,000 people—is not known for this traditional urban-rural split. Rather, the main social divide in the state is between the relatively prosperous south, which has a number of small cities and coastal resorts and is within commuting distance of Boston, and the struggling north, which is rural and sparsely populated and has traditionally depended on extraction industries such as logging for its income (Knowles, 2003). Howard Middle School, in a high-income suburban community in southern Maine, is representative of the wealthier portion of the state. The school and district are well funded, and educational efforts are firmly supported by the children's parents, a high percentage of whom are professionals. The community's

median household income was more than \$58,000 in 2000, a figure some 56% higher than the state average.

Howard Middle is known to have one of the more successful laptop programs in the state, and both visitors and researchers are often pointed in its direction. Our observations and interviews at the school confirmed the success of the laptop program and also pointed to how that success is intimately tied to the broader values, goals, and organization of the school. Simply put, Howard is a school dedicated to promoting academic expertise and research skills, and the use of laptops is geared toward this end. The overall academic direction of Howard was made very evident from our discussion with a school counselor, who explained that a serious career counseling initiative begins when students are in the fifth grade and continues throughout all 4 years of the Grade 5–8 school. When we expressed surprise at how thorough the career counseling was for such a young age, the counselor explained that if fifth and sixth graders want to eventually get their master's or Ph.D. degrees, they need to start planning early. It was the first and only occasion that I had ever heard a school counselor discuss preparing fifth graders to take on doctoral work.

Howard students' training in information literacy also begins in the fifth grade even though they don't enter the laptop program until 2 years later. All fifth graders attend a 45-minute weekly training session led by the librarian, Ms. Gompers, a highly accomplished professional who has two master's degrees and a quarter-century of educational experience and who had earlier won the statewide School Library Media Specialist of the Year award. She takes the students through a detailed process of how to search for information, starting with the school's electronic catalogs and proceeding through other electronic and print resources, such as reference books and periodical indexes. Ms. Gompers explained to me her approach to information literacy:

I'm teaching them about keywords and we were using a printed encyclopedia as an example but we also have the online version, so I'm tying in the fact that for the skills that we are learning, it doesn't matter if it is online or in print, in your hand or on a CD. I'm teaching them that the traditional research skills still have value in this modern world where information comes in many different formats, print and nonprint. And then today, the lesson that we are doing is bringing it right down to their level; we are using phone books and using keywords to search in phone books to find information. I really wanted to emphasize today that it is the process, not the product, that we are concerned with. The

process is learning how to access information and all these research tools that we have used right here. But when they get to be adults and are at home in the afternoon without a teacher or librarian beside them, they may have a need for information, and the skills that we are teaching them are transferable to “everyday life,” and so we were using a phone book. Next week, we are going to be looking at using keywords on the Internet, in search engines and directories. After April vacation when they come back, we are going to do a big research project on a famous American. And they are going to have a chance to use all those skills that we have been working on.

Ms. Gompers has developed special bibliography forms with places for students to write down the citation for their sources (with an example on the top of the form of a correctly formatted citation), the search keywords that they used, and their notes on the information that they found. We regularly found students using these forms for their research, whether done from print sources in the library or from online sources using their laptops.

Ms. Gompers has also put considerable time and effort into assembling online academic resources and teaching students how to use them. The school subscribes to Grolier Online, which offers three distinct encyclopedias, as well as World Book Online. In addition, all schools in Maine have access to a suite of 25 online databases, including magazines, news articles, reference works, biographies, radio and television transcripts, country reports, and primary source documents, from EBSCO information services.

Unlike other schools we visited, where students most frequently used general Internet searches for their research (e.g., Google, Yahoo!, or Ask.com), at Howard, students tended to prefer more academic sources for their online information. As one student told us, in a fairly typical comment, explaining why she prefers to use an encyclopedia, “Well sometimes on Google, you don’t really know where the sources are coming from and you don’t know if they are accurate and trustworthy.”

These critical views toward unknown sources are nurtured early on at Howard, again, long before students get their laptops. Ms. Gompers provided an example to us of her work with a sixth-grade student at the library.

Last year, I had a student who was doing rainforest research, and went to Google. And Googled her animal or bird, and then unfortunately, she hadn’t done what I asked students to do, and

that is immediately do your bibliography. So it is time to pull all the pieces together and she's got notes hanging out there that she doesn't have a bibliography written, so she comes to me and she asks me to help her with it. So of course I did. So we sat down and when we got to the site that we used, I realized that this site had been made by a student somewhere else in the country, and I asked her if she had evaluated this site. And she said, "Uh no, I didn't do that." So we sat down and looked at the site and we looked for the author and looked for the credentials and tried to find out why it was created and so on. And as we went down through the questions, she said to me, "I don't think this is such a good site." And I said, "You are absolutely right." Now there may be good information here, but we have no idea how careful this student was and we don't know why this student was an expert to put it out there on the Web. So we went back and we found some other sites connected through an encyclopedia.

Howard is a school with a strong degree of parental involvement, as evidenced by the numerous parent volunteers we witnessed during our visits. To further involve parents in supporting their children's information literacy, Ms. Gompers organizes evening programs for parents, at which she introduces the online materials available through the encyclopedia subscriptions and EBSCO database and encourages parents to make use of them for their own needs—for example, to consult with *Consumer Reports* magazine before making purchases.

Technology-enhanced research at Howard goes far beyond finding and critically evaluating online information. Rather, these discrete information literacy skills are part of a broader process of critical inquiry that begins when students enter the school in the fifth grade, and extends from there. By the time students enter the one-to-one laptop program in the seventh grade, they are making use of the computer and the Internet for highly interactive forms of learning as they work individually and in groups to define questions or problems, gather and analyze information and data, and develop high-quality products as a means of presenting their findings. These types of learning experiences took place in each of the main subject areas and also in interdisciplinary projects that were organized across subjects.

For example, to better understand the U.S. Constitution in social studies class, students visited the Web site of the Bill of Rights Institute, where they found information on recent court cases involving key constitutional issues. Students explored the site and selected cases that interested them, which often involved issues of relevance to youth. For example, some stu-

dents selected the case involving an atheist's challenge to the Pledge of Allegiance, and others chose a case involving a student's use of his camera phone to take and share embarrassing pictures of other students without their knowledge or permission. The students then read both their case and the background information on it, developed an opinion about the case, and wrote an essay expressing their opinion, which they e-mailed to the teacher. They then shared and debated their opinions in class. This activity represents a very different approach to the Constitution than that typically found in schools, in which students focus their effort on memorizing key facts (e.g., content of the Constitution and its amendments, names of signers, historical dates). In contrast, the Bill of Rights activity described above forces students to grapple with the meaning of the Constitution and its applicability in today's world.

Students in mathematics classes carried out stock market projects in which they selected and researched companies, simulated investments in stock, developed spreadsheets to track their earnings, and wrote reports incorporating their data analysis. The teacher had attempted similar projects in the past but could not include student research on companies because the information simply wasn't available in the school library. Now students are able to carry out and incorporate research on companies and track stocks in real time. The math teacher explained to me the importance of this real-time information:

If they need to get research, they can access it wherever they are. A teacher in the classroom says, "I wonder if something big happened in Iraq yesterday. I wonder what that did with the stock." We open [the laptops] up; we're on the stock market page. It's immediate, any time, anywhere learning, access to data and information, whenever you want it. Say, "Alright, you guys go over and write." These guys are going to do some research. We're going to be doing spreadsheets and graphing. The tool's there whenever they need it.

One time annually, an entire grade level at Howard comes together for a broad interdisciplinary collaborative project. During our visits to the school, the seventh-grade students were working on a major project investigating the industrial revolution and examining the concept of progress, as it applied in four areas: Western expansion, technological progress, women's rights, and slavery. Students worked within one of these four areas, developing both an essay and a multimedia presentation on their particular subtopic and how it relates to the overall theme of progress. For example, one student we observed and interviewed was investigating

the history of railroads in the United States and the particular ways that they contributed to or hindered social, economic, and technological progress. As with all essays at the school, they required a detailed bibliography with citation of scholarly sources. As for the multimedia presentations, they included posters, skits, slide presentations, videos, and games, and were presented to parents and the community at a special evening show.

DISCONNECTED AT PLUM HIGH

Not all schools we visited were as successful as Howard Middle in promoting research skills with technology. A contrary example is seen at Plum High. Plum is located in one of the most sparsely populated rural counties in Maine, with only four people per square mile. The medium household income in the county is just 75% of the state average, and less than half that of Howard Middle's community. Plum was one of the first high schools in the state to implement a one-to-one laptop program when the owners of a local mill gave a large grant to the school for equipment. Interviews with the mill spokesperson and others in the community suggest a variety of motives for the grant, ranging from revitalizing the local economy to developing a more trained workforce to returning a favor to the state governor (who was at the time promoting the laptop program and had reportedly been helpful in facilitating permits and licenses for the mill).

A visitor to Plum quickly learned that the school had a very different academic climate from that of Howard. Whereas Howard's walls featured posters promoting critical thinking, Plum's walls were adorned with military recruitment posters. One wall display indicating the plans of 12th graders revealed that only half the students who entered the school 3 years earlier had persisted until graduation, and, of those, a large percentage were entering the armed forces. The counselors' office indicated that it had no formal career counseling program and instead devoted much of its efforts to handling disciplinary problems that, unlike elsewhere, had increased since the launching of the laptop program. Elsewhere on campus, the school's main librarian only worked part time. Her assistant indicated to us that there was no information literacy program at the library and that few of the students or teachers at the school were even aware of the state-subscribed online databases.

Our classroom observations and interviews confirmed a lax approach to online research at Plum. Most students chose Google as the first and last instrument of online research. Whereas teachers at Howard were critical of citations in student papers of miscellaneous Web sites (preferring

that students cited more authoritative sources, whether in print or online), Plum teachers we interviewed bragged about their students' citations from any Web source, viewing them as a sign of digital sophistication. And although teachers at Plum assigned what might be called research projects, the learning processes and outcomes were dramatically different from those at Howard.

For example, a typical social studies research project at Plum, and one that we had the opportunity to observe in detail, involved students developing and presenting PowerPoint presentations on particular U.S. subcultures, such as the Apache Indians, the Amish, the homeless, cowboys, or Hispanics. Students were neither provided with, nor asked to develop, any research questions as they worked on this task. Most students simply surfed the Web to gather quick information, often highly stereotypical, which they then cut and pasted into their PowerPoint presentations. The rest of the time was then spent finding and inserting clip art or photos—again, usually stereotypical of the subgroup—and embellishing their presentation with glitzy but purposeless transitions and backgrounds. One representative presentation that a student developed on Hispanic culture contained eight slides, each with different backgrounds, fonts, and colors, but with virtually no original text. The second slide, typical of the content of that and many other students' presentations, contained this passage—lightly revised from an online fact sheet—together with a couple of stereotypical food photos:

In Hispanic countries, a light meal is served for breakfast. Lunch, usually is the main meal of the day for Hispanics. In some countries, it is customary for adult family members and children to come home from work or school for about two hours to be together for this meal. *La siesta*, which is a rest period taken after lunch, is known to be a common practice among adult Hispanics. In the early evening, a light snack of coffee and rolls or sandwiches, is served. This meal is often very informal and may be just for children. In the evening, often as late as 9:00 p.m., a small supper, concludes the day's meals. Midday and evening meals are important family or social events. Especially when guests are present, a time to linger and talk over coffee or perhaps an after-dinner drink. Usually when food or additional servings are offered to Hispanics, they tend to accept only after it is offered a second or third time.

The students then marched up to the front of the class one by one to deliver their presentations. Typically the students faced the screen (i.e., away from the audience) and read out loud the material that they had just cut and pasted. Most other students paid little attention to the presentations as they either continued working on their own PowerPoints or occupied themselves with surfing the Web or instant messaging their friends.

Not all lessons at Plum were as disappointing as this one, and a few of the teachers we observed had a stronger research orientation. But unfortunately, the general approach to information and research noted in this class was not inconsistent with what we observed in a number of other classes in the school. This type of instruction represents the downside of online information access and demonstrates that it takes more than computers and Internet access to connect students to real learning opportunities.

From our perspective, a number of factors explained the differences in research climate at Howard and Plum. The greater wealth of the Howard community and school district, and the desirable suburban location, meant that the district could have its pick of many of the state's best teachers and administrators. Plum, meanwhile, because of its location and depressed local economy, had difficulty even filling some of its teaching positions, and the school's principal, who has since left, was viewed by many at the school as ineffective. Also at Howard, high academic expectations from parents, themselves largely professionals, kept the administration and staff on their toes, a factor that was less evident at Plum. Finally, because the statewide middle school program started before the high school program, Howard received much more guidance and support from the statewide Maine Learning Technology Initiative than did Plum, which to a certain extent was on its own.

What is important, though, is not so much the distinction between these two schools, but the broader trends that they represent. For schools that are already dedicated to promoting critical thinking and inquiry, laptops will prove to be an especially powerful learning tool. Schools without that orientation, though, will not magically transform themselves merely through the use of laptops. We do not believe that these differences in orientation are automatically determined by SES. Differences between Howard and Plum were certainly shaped by the two school's socioeconomic context but were also affected by the vision and leadership of the administration at the two schools. To illustrate the role that leadership plays, we turn to a third school, Castle Middle.

EXPEDITIONARY LEARNING AT CASTLE MIDDLE

Castle Middle represents a fascinating alternative to both Howard and Plum, and indeed to any other school in Maine, in both its demographics and teaching approach. Castle is located in one of southern Maine's main cities. It serves the most ethnically, linguistically, and economically diverse population of any school district in Maine. About 25% of its students are African, Asian, Middle Eastern, and Latin American refugees and immigrants from working-class neighborhoods; some 17 countries and 28 languages are represented among the school's small population. About 50% of its students are White youth from some of the most destitute housing projects located on the Eastern Seaboard. And about 25% of its students are middle-class or upper-middle-class students from other surrounding neighborhoods. As a highly diverse school within one of Maine's wealthier southern counties, it thus falls outside the state's traditional north-south categories.

In the school's earlier years, the kind of inequality described above between Howard and Plum were reproduced within Castle's walls, with seven distinct educational tracks, including one for the highly gifted, one for the accelerated (but not gifted), one for special education, one for non-English speakers, and several others calibrated by ability. A new principal was hired who had a mission of promoting an equal and quality education for all Castle students. The principal, Mr. Miller, turned to a national pilot program developed by Outward Bound and in 1992 became one of nine "Expeditionary Learning Outward Bound" schools (for information on the history, learning principles, and practices of this movement, see Expeditionary Learning, 2006). The Expeditionary Learning program involved a complete remaking of the school and its curriculum. Tracking was no longer practiced, and students from special education and English as a Second Language (ESL) programs were integrated into regular classrooms to the maximum extent possible. All students were grouped into "houses" of about 60 learners and four main teachers, with the teachers in each house having broad autonomy over class scheduling. Most houses developed highly flexible block scheduling, with classes meeting for different lengths of time on different days and ample time built in for teacher collaboration. Most important, almost all academic work in the houses and school was integrated into 8–12-week interdisciplinary research projects. These projects, called learning expeditions, are designed to break with what Mr. Miller termed "the tyranny of coverage of curriculum" and instead involve students in collaborative inquiry on thematic issues. These learning expeditions are somewhat similar to the Howard project described above (on the topic of

progress), except that there are two or more of these projects a year at Castle, and they thus constitute the majority of the school curriculum.

In the mid to late 1990s, the Expeditionary Learning model evolved as the school's technology coordinator and classroom teachers worked to make new media central to many areas of learning, with students using computers, the Internet, and other digital media to carry out inquiry and develop products. Later, the school issued laptops to all students in the seventh grade (2002) and eighth grade (2003), and one-to-one computing further supported students' research. Students use laptops to gather data on their research topics, to write up their investigations, and to produce multimedia products on their findings, incorporating texts, images, sounds, and video. This is in line with the school's focus on what has been termed "representing-to-learn" (Zemelman, Daniels, & Hyde, 1998, p. 194). Expanding on a previous concept of writing-to-learn, representing-to-learn simply means that students learn best when they are required to continually represent what they have learned through texts, art, music, drama, or other products or performance media, and that learning is further enhanced when the products are shared with the public through performances, displays, and Web sites. The media specialist at the school explained this approach and the role of laptop use in implementing it:

What we really try to focus on is saying, "What are you going to make at the end of the day that can include everybody's work in it, that becomes a socially constructing environment of knowledge that everybody's trying to put together?" The laptops, to the extent that we are doing this well, allow kids to produce information in a variety of ways and media. So we get this big, broad canvas for catching a lot of different stuff, and if we're smart, we don't just represent it once and publish it and make it finished product, but we take all that stuff and we create a social environment, where everybody looks at each other's work and has a chance to comment on, add to, or connect to what each person's saying. And so socially we construct this picture of a curriculum, and then after a round of that, we might publish. It shows kids that you begin something, you work on it for a while, you do some editing, but eventually you show us what you learn. And I think with the laptops, we're in the process of getting to a place where they can really blow the lid off the traditional way of doing the work because it takes away a lot of limitations.

The learning expeditions provide a means to carry out this work. For example, in one expedition, called Four Freedoms, eighth-grade stu-

dents drew on a 1941 speech by Franklin Roosevelt, a subsequent series of paintings by Norman Rockwell, and other information gathered online to examine freedom of speech, freedom of worship, freedom from fear, and freedom from want. Using magazine materials, the students produced art collages on one of these four freedoms to explore how the ideas of freedom change over time and how some people's freedoms may conflict with others (see sample collage on freedom of speech in Figure 1). The students' then wrote commentaries in which they explained the significance of their collages. Finally, the students assembled the commentaries and collages both in posters that were exhibited at the Maine College of Art and in a hypertext that was published on the World Wide Web.

Figure 1. Castle Middle School Student Collage on Freedom of Speech



In another recent learning expedition, called *Fading Footprints*, seventh-grade students collaboratively investigated how diversity strengthens an ecosystem (see details of this expedition in Grant, n.d.). Each participating student produced a species page, incorporating factual information, an essay, and artwork on a different endangered species, and the work was incorporated into a CD, together with 25 concept pages on related topics such as diversity, extinction, and the Endangered Species Act. The CD was then widely distributed to educational groups throughout the state.

To consider how such overall projects framed and supported students' development of information literacy and research skills, a comparison of Castle's *Fading Footprints* expedition to the earlier-discussed research project at Plum High on subcultures is informative. In both cases, students investigated particular subtopics within a broader theme. At Plum, for example, each student chose a different subculture, whereas at Castle, each student in the *Fading Footprints* project selected a species. However, at Castle, students were able to situate their own research within broader and more relevant research questions. Therefore, together with the facts that they gathered about their species (on topics such as habitat, present status, diet and feeding habits, and causes of endangerment), they also had to write an essay relating their own findings to the overall research question of how diversity strengthens an ecosystem. The essays were of mixed quality, reflecting the comparatively limited language and literacy skills of many Castle students; nevertheless, the very act of working on the essays served to distinguish this type of project from a mere collection of facts such as that in the subculture assignments carried out at Plum. Students who completed their species pages more quickly also produced concept pages, allowing more in-depth conceptual work by students who were able to do so. All the students were then required to read each of the 25 concept pages and to insert hyperlinks in their own work to several key concepts from the concept pages. This activity, once again, helped students connect their own fact finding to broader concepts and ideas. Finally, students at Castle were provided scaffolding for their work through detailed peer editing during a "critique week" and with the assistance of teacher-supplied rubrics.

Castle students also actively engage in documenting the research process. Each expedition deploys a student production team that videos the learning activities, interviews students and teachers, and produces a documentary CD on the expedition and learning process distributed to all participating students and their families. The documentary helps develop further multimedia skills for the members of the video team and

encourages all the students in the expedition to reflect on the research and learning process.

Also of interest is Castle's approach to instruction of English language learners. Castle has ended separate ESL instruction at the intermediate and advanced levels in the main subject areas and instead integrates English language learners into the regular classroom. ESL specialist teachers are assigned to each house to work closely with classroom teachers and students to provide curricular and pedagogical support and scaffolding for English language learners as they work on the same learning expeditions as their native-English-speaking peers. Meanwhile, students in beginning ESL classes also work on learning expeditions, sometimes in partnership with the regular classes and sometimes on specially devised expeditions targeted at their skill level. But whether ESL students are at the beginning, intermediate, or advanced levels, computer-based drill programs for learning English are eschewed, and laptops are instead used as a tool of apprenticeship for the kinds of research and writing activities that all students are expected to carry out. From our observations and interviews, we learned that the multimodal, multi-tiered products created through learning expeditions provide students a vehicle for drawing on varied strengths and making positive contributions, regardless of whether they are fluent in English.

In summary, Castle represents a radical break with traditional curriculum and pedagogy in favor of inquiry-based and project-based learning. In California and elsewhere, many teachers and schools shy away from such approaches, believing that they might negatively affect student test scores. Interestingly, though, Castle's combined test scores in reading, writing, mathematics, and science have exceeded the state average in Maine in 2004–2005, as they have for a number of years, in spite of the school's large numbers of non-native speakers of English and low-income students. Castle has thus shown that project-based learning and intensive technology use can be combined for academic success with diverse students.

CONCLUSIONS

Widely valued 21st-century learning skills revolve around working with information to produce knowledge. Our investigation into the 10 schools illustrated the decided advantage that the laptop classroom has for facilitating these kinds of skills. Students in laptop classes had more frequent opportunities for just-in-time learning, individualized learning, and

empirical investigation. Laptop use made it much more feasible for students to engage in research projects and also created better possibilities for in-depth learning.

However, these beneficial outcomes occurred unevenly in the schools we visited. Though all students had frequent access to information, not all received the instruction and scaffolding necessary to develop information literacy and research skills. In particular, teachers in high-income communities were more likely to expect and promote critical inquiry and information literacy than were teachers in low-income areas. This discrepancy is consistent with previous research on technology use in non-laptop schools, which has similarly found more promotion of higher order thinking skills with technology in high-SES than low-SES schools (see, for example, Becker, 2000a; Schofield & Davidson, 2004; Warschauer, 2000; Warschauer et al., 2004; Wenglinsky, 1998). To a certain extent, this finding is a reflection of the broader socioeconomic context of today's world and the social sorting mechanism of U.S. schools (see Kozol, 2005). Though most workers will require some information technology skills to function in tomorrow's workforce, those skills are bifurcated between knowledge-producing functions (e.g., analysis, interpretation, research) and administrative functions (Internet browsing, basic communication, and file maintenance; see discussion in Castells, 1999; Gee, Hull, & Lankshear, 1996; Warschauer, 2000). It is thus not surprising that schools that see themselves producing the academic and business elite tend to emphasize the former set of skills and that schools that see themselves as preparing students vocationally tend to emphasize the latter.

However, our research in laptop schools suggests that these patterns are not set in stone. Though socioeconomic context is an important variable, vision, values, and beliefs are also crucial factors. Those schools that have a vision for promoting information literacy and research skills with diverse students and that can mobilize their teachers behind that vision are finding that one-to-one laptops are a powerful tool in realizing this goal.

In summary, laptops will not make bad schools good, but they will make good schools better. When part of an instructional program promoting critical inquiry, individually assigned laptops with wireless Internet connections are an invaluable tool for helping students develop the information literacy and research skills required for success in the 21st century.

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MARK WARSCHAUER is Professor of Education and Informatics at the University of California, Irvine. His research focuses on the literacy practices of culturally and linguistically diverse students using digital media. His most recent book is *Laptops and Literacy* (Teachers College Press, 2006).